Project Assignment for EE 559, Spring 2016, Dr. McCalley

Project overview: Students enrolled in EE 459 do not need to complete a course project. Each student enrolled in EE 559 is required to complete a course project. The end result of the course project will be a 5-8 page technical paper (written in the format of an IEEE technical conference paper – see the "MSWord Template" located at http://www.ieee-pes.org/templates-and-sample-of-pes-technical-papers), and a 10-minute recorded presentation. The presentations will be played to the class during the last three classes. (We will extend these three classes by 15 minutes each, ending them at 6:45pm, to give us 90 minutes per class, so that we can have 90/8≈11 minutes per presentation.) All presentations should be pre-recorded using the voice-over in powerpoint. (All technical papers and recorded presentations are due on Wednesday, November 30, 2016 and should be posted to the course Cybox on that day; presentations will be shown in-class on Wednesday, November 30, Monday December 5, and Wednesday December 7. Some additional information about the project follows:

1. Subject to the work areas given at the end of this document, EE 559 students are responsible for identifying their own project objective.
2. Each EE 559 student should send to Dr. McCalley, by Friday, September 16, 2016, a two-page (11 pt font, standard margins) *project proposal* which states project objective and why the objective is important, previous work related to the objective (on which you will build), the approach you will take, what will be the project deliverable(s), and the project work schedule. You should start on this immediately after receiving the guidelines.
3. Your project proposal will count 5% of your overall course grade. Grading criteria for the project proposal will be (a) significance of the objective; (b) capture of previous work; (c) creativity of the identified approach; and (d) usefulness of the final deliverable.
4. The work you report should not be work you have already performed previous to enrolling in this class. It can be work that you end up using in the future in your job or your research.
5. Expectations are that the technical papers would be at least 5 pages in length and not to exceed 8 pages in length (including bibliography). Suggested sections for the technical paper are "Abstract", "Introduction," "Basic concepts," "Recent work in advancing state-of-art," "Industry applications," "Conclusions," and "Bibliography." You should post your paper to the Cybox.
6. Presentations must not exceed 10 minutes; this is a hard constraint! Your presentation should identify the project objective, any basic concepts, recent work in advancing state-of-art, and industry applications. Your presentation will be graded based on clarity, organization, presentation enthusiasm, and eye contact with the audience (through the camera). You must identify at least one concept within your presentation which is new to the rest of the class, and in presenting this concept, you are truly serving as an instructor. Make sure you identify this concept. I will take note of it and may develop a question on the final exam related to it.
7. For the voice-over powerpoint, make sure the audio is embedded and NOT linked; you can test this by making sure the audio works on another device). Include your picture and e-mail address on slide 1.
8. For each project, a group of four students in the class will be identified to ask one question per student and then email their question to the presenter. The presenter must then prepare a response to each question (identifying the person who asked the question) and upload to the Cybox by Friday, December 7, 2016. Assignments for the groups of student questioners is provided below.
9. Your project technical paper will be graded based on the quality of the information that you present in terms of correctness, breadth of coverage relative to the chosen topic, and responsiveness to the provision of the desired information (as described at the bottom of this page), and writing quality.

Project Guidelines: You may choose your project topic from one of three different work areas, as described below.

Work area 1, Large Turbines: The largest inland wind turbines today are on the order of 5-6 MW. For example, Sinovel makes a 6 MW turbine that it claims can be used inland or offshore, and they indicate (http://news.xinhuanet.com/english2010/sci/2011-05/30/c_13901383.htm) they would like to manufacture a 10 MW turbine. A more recent article about the Sinovel 6 MW machine is here: http://www.sinovel.com/english/content/?112.html. Additional information about this turbine and other large turbines can be found here: http://www.windpowermonthly.com/10-biggest-turbines (but notice that most of these are for offshore use). Increasing the size of wind turbines is of interest because it is believed that doing so will realize significant economies of scale, i.e., the cost per MWhr produced will decrease as turbine size increases. This cost decrease will occur as a result of decreased cost realized in the manufacture, installation, maintenance, operation, and retirement of, for example, one turbine of size 15 MW as opposed to ten turbines of size 1.5 MW.

However, no manufacturer is building n inlanda 10-15 MW turbine today; it appears that doing so will require increasing the turbine height, decreasing the turbine weight, increasing efficiency, and reducing cost.

The objective of your project is to identify some innovative idea related to design of the electric generator and assess its value in terms of providing the ability to build a 10-15 MW wind turbine. Some ideas that you may consider include:

1. Investigation of one of the types of permanent magnet generators (e.g., some types include axial flux, radial flux, transversal flux) for a direct-drive configuration
2. Investigation of the tradeoff between use of a small airgap to optimize electromagnetic performance vs. use of a large airgap to reduce mass.
3. Investigation of an attractive converter technology, e.g., matrix converter, three-level neutral point clamped (NPC) converter, the parallel interleaved converter.
4. Investigation of new materials for permanent magnet generators.
5. Investigation of different pole configurations and pole areas
6. Investigation of superconducting generators
7. Use of generators for designs that use hydraulic drive trains (where the mechanical gearbox is replaced by a hydraulic system)
8. Some other EE-related wind turbine design issue for which you have interest, but in this case, you must first discuss with me.

You should perform an extensive literature review related to the point of investigation. The result of this literature review will be a summarization of the current state of technology, possible innovations that would move us toward achieving the 15 MW /turbine, and your assessment in regards to the impact of doing so. This last assessment must address the following general attributes: weight, cost, reliability, efficiency, and performance.

Work area 2, Control: Control of wind energy systems is already a highly evolved area, including the following:

1. Supervisory system: this manages the transitions between regions (off, starting, idling, cut-in, increasing power, maximum power, cut-out) and the monitoring and remote control modules (SCADA).
2. Safety system: acts if severe malfunctions occur, e.g., overspeed, excessive power or torque, significant difference in pitch angles of blades, excessive vibrations, manual emergency shut-down.
3. Yaw controller
4. Aerodynamic power control via pitch controller
5. Variable-speed operation and energy capture maximization, via generator control
6. Control of power transfer to grid via power electronics converter

Alternatively, there are several areas of control which are evolving, including the below:

7. Provision of inertial emulation and governor (droop) control
8. Provision of regulation reserves, i.e., up and/or down regulation
9. Provision of reactive power supply and active voltage control
10. Wind plant control for maximizing plant (as opposed to individual turbine) energy extraction, wake interaction control
11. Some other wind turbine control topic of which you have interest, but in this case, you must first discuss with me.

You should choose one or more of the above control topics and perform an extensive literature review related to it. The result of this literature review will be a summarization of the current state of technology, design methods for the control, and related innovations that would move us toward a more effectively controlled wind turbine and/or wind plant. You should also address the cost and benefits of the control.

Work area 3, Your choice: I am amendable to your selection of other wind-related work areas. However, in this case, you will need to convince me that your selection is indeed a worthy area for you to investigate, and for the whole class to learn about (when you present).

Identification of Questioners for each Presenter

Presenter No.	Presenter name	Student groups to ask questions
1	Rajaz Amitava*	Chartouni, Cao, Chiluka, Huang
2	Vikram Chiluka	Haq,R. Sharma, S. Sharma, Singh
3	Yija Huang	Heinen, Ahmed, Zapata, Dellasandro
4	Rory Jones	Mirza, Feltes, Gnesda, Karim
5	Sameera Kancherla *	Riedl, Kekeocha, Klyn, Lewis
6	Srikrishna Sarangan	Szostak, Near, Zuluaga, Rust
7	Pranav Sharma	Trischan, Watkins, Amitava, Cao
8	Rishi Sharma	Zaou, Chiluka, Huang, Jones
9	Shikha Sharma	Chartouni, Kancherla, Sarangan, P. Sharma
10	Vivek Singh	Dugan, R. Sharma, S. Sharma, Szostak
11	Hassan Ahmed	Haq, Trischan, Singh, Zapata
12	Carlos Borda Zapata	Heinen, Zaou, Ahmed, Dellasandro
13	Jesse Dellasandro	Mirza, Feltes, Gnesda, Karim
14	Daniel Feltes	Riedl, Kekeocha, Klyn, Lewis
15	John Gnesda	Szostak, Near, Zuluaga, Rust
16	Srijan Karim	Trischan, Watkins, Amitava, Cao
17	Samuel Kekeocha	Zaou, Chiluka, Huang, Jones
18	Aric Klyn	Chartouni, Kancherla, Sarangan, P. Sharma
19	Steven Lewis	Dugan, R. Sharma, S. Sharma, Singh
20	Joseph Near	Haq,Ahmed, Zapata, Dellasandro
21	Maria Pareja Zuluaga	Heinen, Feltes, Gnesda, Karim
22	Matthew Rust	Mirza, Kekeocha, Klyn, Lewis
23	Benjamin Watkins *	Riedl, Near, Zuluaga, Rust
24	Patrick Maloney	Dugan, Jones, Kancheria, Guo
25	Xian Guo	Sarangan, P. Sharma, Maloney